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PB-277 939

Otter Creek Reservoir Piute County, Utah

National Eutrophication Survey, Corvallis, Oreg

Prepared for

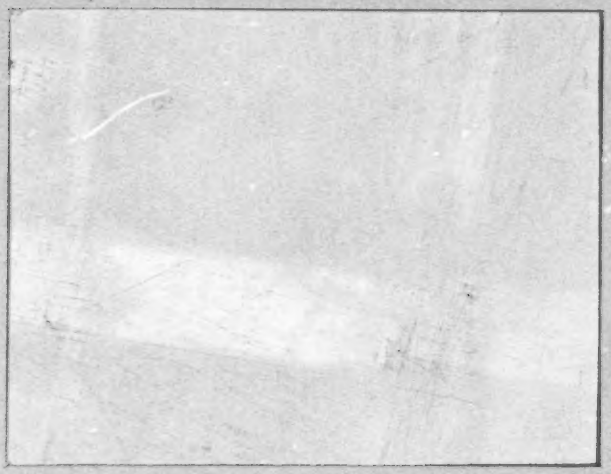
Corvallis Environmental Research Lab, Oreg

Oct 77

PB 277 939

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

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U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

O. 699-440

REPORT
ON
OTTER CREEK RESERVOIR
PIUTE COUNTY
UTAH

EPA REGION VIII

WORKING PAPER No. 850

WITH THE COOPERATION OF THE

UTAH STATE DIVISION OF HEALTH

AND THE

UTAH NATIONAL GUARD

OCTOBER, 1977

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB277939
4. TITLE AND SUBTITLE Report on Otter Creek Reservoir, Piute County, Utah		5. REPORT DATE Prepared October 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 850
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1975 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		48G

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		36
	20. SECURITY CLASS *(This page)*	22. PRICE PCA03-A01

EPA Form 2220-1 (9-73)

1a

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Utah Department of Social Services and the Utah Department of Natural Resources for professional involvement, to the Utah National Guard for conducting the tributary sampling phase of the Survey, and to those Utah wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staffs of the Bureau of Water Quality of the Division of Health and the Division of Wildlife Resources provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

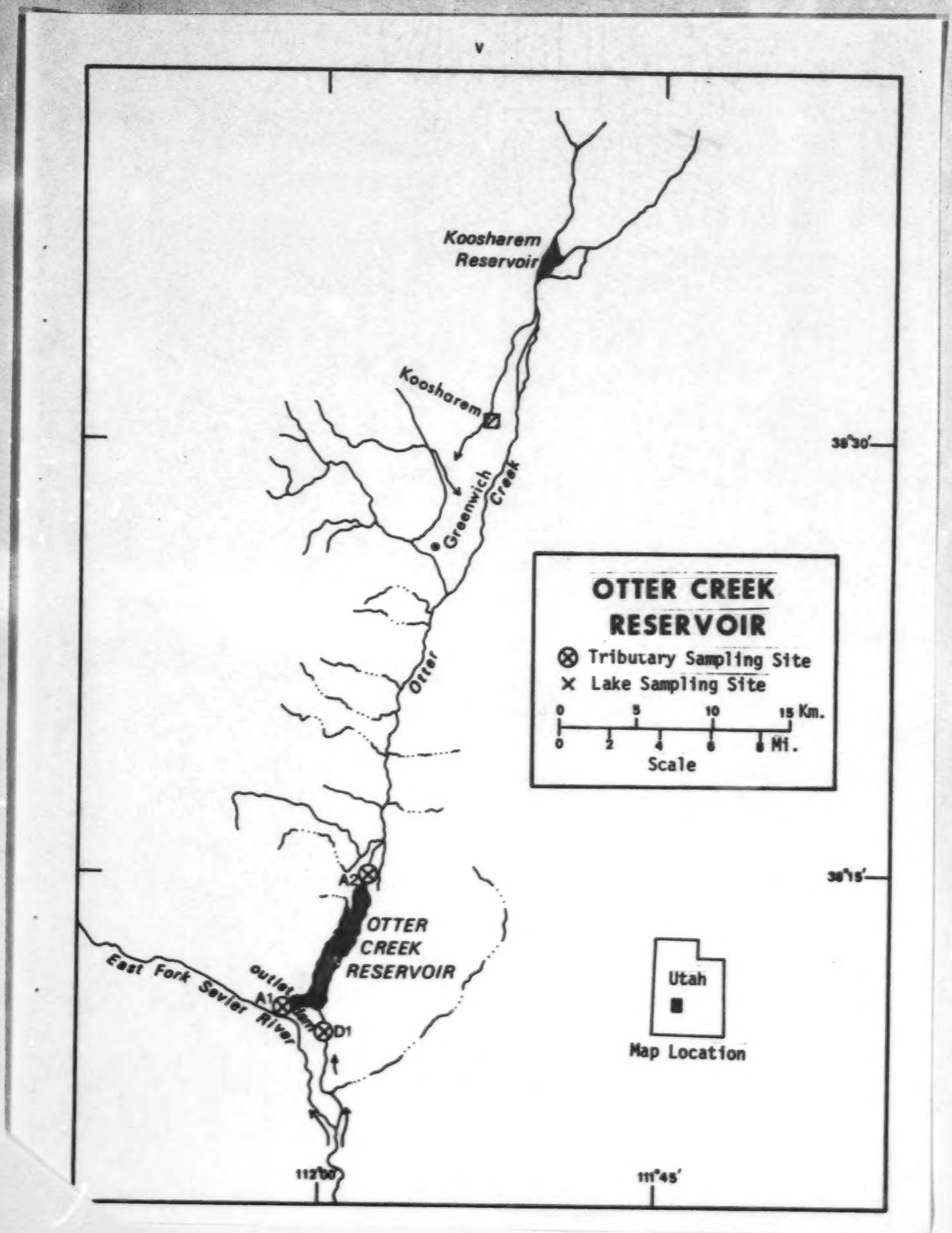
Major General Maurice L. Watts, the Adjutant General of Utah, and Project Officer Lt. Colonel T. Ray Kingston, who directed the volunteer efforts of the Utah National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF UTAH

NAME	COUNTY
Bear	Rich, UT; Bear Lake, ID
Deer Creek	Wasatch
Echo	Summit
Fish	Sevier
Flaming Gorge	Daggett, UT; Sweetwater, WY
Huntington	Emery
Joes Valley	Emery
Lower Bowns	Garfield
Lynn	Box Elder
Minersville	Beaver
Moon	Duchesne
Navajo	Kane
Newcastle	Iron
Otter Creek	Piute
Panguich	Garfield
Pelican	Uintah
Pineview	Weber
Piute	Piute
Porcupine	Cache
Powell	Garfield, Kane, San Juan, UT; Coconino, AZ
Pruess	Millard
Sevier Bridge	Juab, Sanpete
Starvation	Duchesne
Steinaker	Uintah
Tropic	Garfield
Utah	Utah
Willard Bay	Box Elder


Koosharem Reservoir
Koosharem
Greenwich Creek
Otter
OTTER CREEK RESERVOIR
Tributary Sampling Site
Lake Sampling Site
0 5 10 15 Km.
0 2 4 6 8 Mi.
Scale
A2
A1
D1
outlet
East Fork Sevier River
38°30'
38°15'
112°00'
111°45'
Utah
Map Location

OTTER CREEK RESERVOIR

STORET NO. 4913

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Otter Creek Reservoir is eutrophic. It ranked nineteenth in overall trophic quality when the 27 Utah lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Twenty-two of the water bodies had less median total phosphorus, 24 had less median dissolved orthophosphorus, none had less but ten had the same median inorganic nitrogen, 18 had less mean chlorophyll a, and 22 had greater mean Secchi disc transparency. Some depression of dissolved oxygen with depth occurred at sampling station 1 in August (4.4 mg/l at 7.0 meters).

Survey limnologists noted light algal blooms and submerged macrophytes in the reservoir in May and August, and surface scums of algae were observed in the northern fourth of the reservoir in September.

B. Rate-Limiting Nutrient:

The algal assay results indicate the reservoir was nitrogen limited in May and September. The reservoir data indicate nitrogen limitation at all sampling stations and times.

C. Nutrient Controllability:

1. Point sources--No known point sources impacted Otter Creek Reservoir during the sampling year.

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* See Appendix A.

2. Non-point sources--Non-point sources contributed the entire phosphorus load to the reservoir during the sampling year. The East Fork Canal contributed a little over 74% of the total load, and Otter Creek contributed 21%. The estimated phosphorus loading of 0.61 g/m^2/year is about 1.5 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). However, the phosphorus export rate of Otter Creek was a rather low 2 kg/km^2 during the sampling year, so it appears that land-use practices in that drainage do not contribute significantly to the phosphorus load.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 10.20 kilometers^2.
2. Mean depth: 6.3 meters.
3. Maximum depth: 11.3 meters.
4. Volume: 64.758 x 10^6 m^3.
5. Mean hydraulic retention time: 1.4 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Otter Creek	854.7	0.352
East Fork Canal	-	1.230
Minor tributaries & immediate drainage	119.3	0.031
Totals	974.0	1.613

2. Outlet -

East Fork Sevier River	984.2**	1.437

C. Precipitation***:

1. Year of sampling: 20.7 centimeters.
2. Mean annual: 20.7 centimeters.

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† Table of metric conversions--Appendix B.
†† Sudweeks, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir; lesser outflow due to evaporation.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Otter Creek Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 8.2 meters at station 1 and 6.1 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR OTTER CREEK RESERVOIR
STORET CODE 4913

PARAMETER	1ST SAMPLING (5/ 9/75) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/13/75) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/25/75) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	7.2 - 9.6	8.3	8.4	18.2 - 20.4	19.3	18.9	17.4 - 18.8	18.0	18.0
DISS OXY (MG/L)	8.2 - 9.2	8.8	8.9	4.4 - 8.4	7.2	7.6	5.6 - 8.4	7.1	7.2
CNDCTVY (MCROMO)	300. - 466.	383.	383.	406. - 421.	416.	419.	309. - 324.	318.	318.
PH (STAND UNITS)	8.6 - 8.7	8.6	8.6	8.5 - 8.9	8.8	8.8	8.8 - 9.0	8.9	8.9
TOT ALK (MG/L)	226. - 288.	258.	256.	179. - 190.	184.	186.	166. - 174.	170.	171.
TOT P (MG/L)	0.053 - 0.068	0.063	0.065	0.058 - 0.124	0.083	0.084	0.055 - 0.086	0.073	0.078
ORTHO P (MG/L)	0.003 - 0.013	0.007	0.006	0.024 - 0.095	0.050	0.053	0.034 - 0.045	0.040	0.041
NO2+NO3 (MG/L)	0.020 - 0.030	0.021	0.020	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.020 - 0.040	0.030	0.030	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020
KJEL N (MG/L)	0.400 - 1.600	0.637	0.550	0.300 - 0.700	0.443	0.400	0.400 - 0.600	0.457	0.400
INORG N (MG/L)	0.040 - 0.070	0.051	0.050	0.040 - 0.040	0.040	0.040	0.040 - 0.040	0.040	0.040
TOTAL N (MG/L)	0.420 - 1.630	0.659	0.570	0.320 - 0.720	0.463	0.420	0.420 - 0.620	0.477	0.420
CHLRPYL A (UG/L)	13.0 - 16.1	14.5	14.5	10.7 - 13.4	12.0	12.0	8.5 - 8.9	8.7	8.7
SECCHI (METERS)	0.6 - 0.6	0.6	0.6	1.4 - 1.8	1.6	1.6	1.2 - 1.5	1.4	1.4

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/09/75	1. Cyclotella sp.	5,323
	2. Flagellates	1,331
	3. Chroomonas sp.	1,065
	4. Chlamydomonas sp.	887
	5. Cryptomonas sp.	444
	Other genera	486
	Total	9,536
08/13/75	1. Fragilaria sp.	4,919
	2. Anabaena sp.	642
	3. Ceratium sp.	214
	4. Melosira sp.	214
	5. Cryptomonas sp.	53
	Other genera	76
	Total	6,148
09/25/75	1. Cryptomonas sp.	446
	2. Anabaena sp.	74
	3. Ceratium sp.	74
	Total	594

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
05/09/75	1	16.1
	2	13.0
08/13/75	1	10.7
	2	13.4
09/25/75	1	8.5
	2	8.9

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. May sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.015	0.065	2.5
0.050 P	0.065	0.065	2.6
0.050 P + 1.0 N	0.065	1.065	29.1
1.0 N	0.015	1.065	10.5

b. September sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.030	0.050	4.2
0.050 P	0.080	0.050	4.8
0.050 P + 1.0 N	0.080	1.050	24.3
1.0 N	0.030	1.050	8.9

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Otter Creek Reservoir was moderately high at the times the samples were collected (05/09/75 and 09/25/75). Also, the significant increases in yield with the addition of nitrogen alone indicate the reservoir was limited by nitrogen at those times.

The reservoir data also indicate nitrogen limitation; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 7/1 or less at all sampling times.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Utah National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of May when two samples were collected. Sampling was begun in November, 1974, and was completed in October, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Utah District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Otter Creek at station A-2 and the mean annual ZZ flow.

No known wastewater treatment plants impacted the reservoir during the sampling year.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Otter Creek	1,345	21.0
East Fork Canal	4,770	74.3
b. Minor tributaries & immediate drainage (non-point load) -	120	1.9
c. Known municipal STP's -	None	-
d. Septic tanks -	Unknown	?
e. Known industrial -	None	-
f. Direct precipitation* -	180	2.8
Total	6,415	100.0

2. Outputs -

Reservoir outlet - East Fork Sevier River 4,305

3. Net annual P accumulation - 2,110 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Otter Creek	25,145	27.5
East Fork Canal	53,105	58.1
b. Minor tributaries & immediate drainage (non-point load) -	2,215	2.4
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	11,010	12.0
Total	91,475	100.0

2. Outputs -

Reservoir outlet - East Fork Sevier River 54,970

3. Net annual N accumulation - 36,505 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Otter Creek	2	29

E. Mean Nutrient Concentrations in East Fork Canal:

Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
0.123	1.368

* See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.61	0.21	9.0	3.6

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Otter Creek Reservoir:

"Dangerous" (eutrophic loading)	0.42
"Permissible" (oligotrophic loading)	0.21

V. LITERATURE REVIEWED

Sudweeks, Calvin K., 1975. Personal communication (reservoir morphometry). UT Bur. of Env. Health, Salt Lake City.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

APPENDIX A
LAKE RANKINGS

CODE LAKE	LAKE NAME	TOTAL P MEDIAN	INORG N MEDIAN	MEAN SEC 300-	CHLORPH MEAN	MIN DO 12-	DISS ORTHO P MEDIAN
LAKE DATA TO BE USED IN RANKING							
0408	LAKE POWELL	0.010	0.010	376.820	3.091	12.000	0.001
0411	BEAR LAKE	0.011	0.040	523.191	0.692	4.500	0.003
0415	POWER ROAD#2 RESERVOIR	0.031	0.040	330.000	2.291	8.000	0.008
0418	DEER CREEK RESERVOIR	0.038	0.512	420.333	8.018	10.500	0.000
0419	ECHO RESERVOIR	0.041	0.110	420.333	0.691	10.000	0.015
0422	FARM RESERVOIR	0.151	0.500	411.893	10.809	10.000	0.025
0424	FISH LAKE	0.052	0.040	125.000	15.083	10.000	0.004
0427	HUNTINGTON NORTH RESERVO	0.013	0.040	305.000	1.000	1.000	0.002
0428	JOES VALLEY RESERVOIR	0.015	0.042	400.000	5.083	11.500	0.003
0430	MINERSVILLE RESERVOIR	0.185	0.040	442.000	23.263	8.000	0.101
0431	MOON LAKE	0.008	0.040	381.000	5.400	6.000	0.005
0432	NAVAJO LAKE	0.019	0.040	308.000	5.000	8.000	0.003
0433	NEWCASTLE RESERVOIR	0.027	0.040	458.000	15.091	13.000	0.006
0434	OTTER CREEK RESERVOIR	0.041	0.040	423.000	11.191	10.000	0.033
0435	PANGUITCH LAKE	0.017	0.040	450.200	2.020	14.500	0.010
0436	PARIGAN LAKE	0.044	0.020	438.200	0.320	8.000	0.004
0437	PINEVIEW RESERVOIR	0.058	0.300	432.000	2.085	10.000	0.009
0438	PINTE RESERVOIR	0.041	0.120	485.052	52.358	11.000	0.001
0439	PORCUPINE RESERVOIR	0.052	0.110	400.000	1.080	15.000	0.011
0440	PROVEST RESERVOIR (DUAB1	0.021	0.140	481.000	0.233	8.000	0.008
0441	SEVIER BRIDGE RESERVOIR	0.058	0.322	411.000	19.555	15.000	0.008
0442	STANAVATION RESERVOIR	0.019	0.040	304.293	2.012	13.500	0.004
0443	STEINAKER RESERVOIR	0.011	0.040	318.120	1.000	15.000	0.002
0444	THOMAS RESERVOIR	0.051	0.020	452.000	1.500	9.000	0.009
0445	UTAH LAKE	0.135	0.350	430.283	15.015	11.000	0.015
0446	WILLARD BAY RESERVOIR	0.044	0.040	421.385	1.291	13.000	0.006
0447	YANKEE FORK RESERVOIR	0.011	0.040	583.830	5.000	10.000	0.003

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0404	LAKE POWELL	0.010	0.410	339.630	3.081	13.800	0.007
4901	BEAR LAKE	0.011	0.040	253.167	0.945	9.200	0.003
4902	LOWER BOWN'S RESERVOIR	0.031	0.040	336.000	5.567	9.400	0.006
4903	DEER CREEK RESERVOIR	0.038	0.215	430.333	9.078	14.800	0.006
4904	ECHO RESERVOIR	0.047	0.170	450.333	6.967	14.000	0.012
4905	LYNN RESERVOIR	0.121	0.200	417.667	39.600	10.400	0.052
4906	FISH LAKE	0.023	0.040	152.000	12.483	10.400	0.004
4907	HUNTINGTON NORTH RESERVO	0.013	0.040	392.000	1.900	7.800	0.005
4908	JOE'S VALLEY RESERVOIR	0.012	0.045	400.000	2.483	11.200	0.003
4909	MINERSVILLE RESERVOIR	0.192	0.060	445.000	33.583	8.600	0.107
4910	MOON LAKE	0.008	0.040	381.000	2.700	9.600	0.002
4911	NAVAJO LAKE	0.016	0.040	368.000	2.000	6.000	0.003
4912	NEWCASTLE RESERVOIR	0.051	0.040	428.667	12.467	13.600	0.009
4913	OTTER CREEK RESERVOIR	0.067	0.040	453.667	11.767	10.600	0.033
4914	PANGUITCH LAKE	0.071	0.040	426.500	45.950	14.200	0.010
4915	PELICAN LAKE	0.044	0.050	438.500	6.350	8.400	0.004
4916	PINEVIEW RESERVOIR	0.028	0.300	435.083	5.692	14.600	0.006
4917	PIUTE RESERVOIR	0.047	0.150	482.625	25.329	11.600	0.007
4918	PORCUPINE RESERVOIR	0.025	0.110	440.000	7.860	12.400	0.011
4919	PRUESS RESERVOIR (GARRIS	0.057	0.140	491.000	4.533	8.800	0.008
4920	SEVIER BRIDGE RESERVOIR	0.026	0.355	449.778	18.222	12.400	0.008
4921	STARVATION RESERVOIR	0.016	0.040	394.583	5.675	13.200	0.004
4922	STEINAKER RESERVOIR	0.011	0.040	316.750	1.844	12.600	0.005
4923	TROPIC RESERVOIR	0.021	0.050	425.000	7.200	8.400	0.006
4924	UTAH LAKE	0.132	0.320	490.583	72.012	11.400	0.012
4925	WILLARD BAY RESERVOIR	0.044	0.060	457.182	7.567	11.000	0.009
485	FLAMING GORGE RESERVOIR	0.011	0.690	285.636	2.500	10.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NU
0408	LAKE POWELL	96 (25)	4 (1)	81 (21)	73 (19)	15 (4)	42 (11)	311
4901	BEAR LAKE	90 (23)	87 (19)	96 (25)	100 (26)	77 (20)	90 (23)	540
4902	LOWER BOWN'S RESERVOIR	46 (12)	87 (19)	85 (22)	65 (17)	73 (19)	50 (13)	406
4903	DEER CREEK RESERVOIR	42 (11)	19 (5)	42 (11)	35 (9)	0 (0)	58 (14)	196
4904	ECHO RESERVOIR	31 (8)	27 (7)	19 (5)	50 (13)	12 (3)	13 (3)	152
4905	LYNN RESERVOIR	8 (2)	23 (6)	58 (15)	8 (2)	62 (15)	4 (1)	163
4906	FISH LAKE	62 (16)	65 (16)	100 (26)	23 (6)	62 (15)	79 (20)	391
4907	HUNTINGTON NORTH RESERVOIR	77 (20)	65 (16)	69 (18)	92 (24)	96 (25)	69 (18)	468
4908	JOE'S VALLEY RESERVOIR	81 (21)	58 (15)	62 (16)	85 (22)	46 (12)	96 (25)	428
4909	MINERSVILLE RESERVOIR	0 (0)	44 (11)	27 (7)	12 (3)	85 (22)	0 (0)	168
4910	MOON LAKE	100 (26)	87 (19)	73 (19)	77 (20)	69 (18)	100 (26)	506
4911	NAVAJO LAKE	69 (18)	87 (19)	77 (20)	88 (23)	100 (26)	85 (22)	506
4912	NEWCASTLE RESERVOIR	23 (6)	87 (19)	46 (12)	27 (7)	19 (5)	27 (7)	229
4913	OTTER CREEK RESERVOIR	15 (4)	87 (19)	15 (4)	31 (8)	54 (14)	8 (2)	210
4914	PANGUITCH LAKE	12 (3)	65 (16)	50 (13)	4 (1)	8 (2)	23 (6)	162
4915	PELICAN LAKE	37 (9)	54 (14)	35 (9)	54 (14)	90 (23)	73 (19)	343
4916	PINEVIEW RESERVOIR	50 (13)	15 (4)	38 (10)	58 (15)	4 (1)	58 (14)	223
4917	PIUTE RESERVOIR	27 (7)	31 (8)	8 (2)	15 (4)	38 (10)	46 (12)	165
4918	PORCUPINE RESERVOIR	58 (15)	38 (10)	31 (8)	38 (10)	33 (8)	19 (5)	217
4919	PRUESS RESERVOIR (GARRIS	19 (5)	35 (9)	0 (0)	69 (18)	81 (21)	37 (9)	241
4920	SEVIER BRIDGE RESERVOIR	54 (14)	8 (2)	23 (6)	19 (5)	33 (8)	37 (9)	174
4921	STARVATION RESERVOIR	73 (19)	87 (19)	65 (17)	62 (16)	23 (6)	79 (20)	389
4922	STEINAKER RESERVOIR	85 (22)	87 (19)	88 (23)	96 (25)	27 (7)	65 (17)	448
4923	TROPIC RESERVOIR	65 (17)	50 (13)	54 (14)	46 (12)	90 (23)	58 (14)	363
4924	UTAH LAKE	4 (1)	12 (3)	4 (1)	0 (0)	42 (11)	13 (3)	75
4925	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216
5605	FLAMING GORGE RESERVOIR	90 (23)	0 (0)	92 (24)	81 (21)	62 (15)	90 (23)	415

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4901	BEAR LAKE	540
2	4911	NAVAJO LAKE	506
3	4910	MOON LAKE	506
4	4907	HUNTINGTON NORTH RESERVO	468
5	4922	STEINAKER RESERVOIR	448
6	4908	JOE'S VALLEY RESERVOIR	428
7	5605	FLAMING GORGE RESERVOIR	415
8	4902	LOWER BOWN'S RESERVOIR	406
9	4906	FISH LAKE	391
10	4921	STARVATION RESERVOIR	389
11	4923	TROPIC RESERVOIR	363
12	4915	PELICAN LAKE	343
13	8408	LAKE POWELL	331
14	4919	PRUESS RESERVOIR (GARRIS	241
15	4912	NEWCASTLE RESERVOIR	229
16	4916	PINEVIEW RESERVOIR	223
17	4918	PORCUPINE RESERVOIR	217
18	4925	WILLARD BAY RESERVOIR	216
19	4913	OTTER CREEK RESERVOIR	210
20	4903	DEER CREEK RESERVOIR	196
21	4926	SEVIER BRIDGE RESERVOIR	174
22	4909	MINERSVILLE RESERVOIR	168
23	4917	PIUTE RESERVOIR	165
24	4905	LYNN RESERVOIR	163
25	4914	PANGUITCH LAKE	162
26	4904	ECHO RESERVOIR	152
27	4924	UTAH LAKE	75

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4913 OTTER CRK RES

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 984.2

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4913A1	984.2	0.028	0.028	0.028	0.878	2.180	3.115	4.248	3.681	2.520	0.340	0.057	0.028	1.437
4913A2	854.7	0.425	0.934	1.189	0.878	0.068	0.020	0.031	0.093	0.096	0.102	0.119	0.311	0.352
491301	0.0	0.99	1.13	1.13	2.27	2.55	1.13	0.85	0.71	0.99	0.99	0.99	0.99	1.23
4913ZZ	129.5	0.008	0.020	0.020	0.099	0.085	0.071	0.028	0.008	0.008	0.008	0.008	0.008	0.031

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 984.2
SUM OF SUB-DRAINAGE AREAS = 984.2
TOTAL FLOW IN = 19.37
TOTAL FLOW OUT = 17.13

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4913A1	11	74	0.198	12	0.198				
	12	74	0.142	14	0.198				
	1	75	0.142	11	0.142				
	2	75	0.142	15	0.142				
	3	75	0.142	8	0.142				
	4	75	0.170	5	0.142				
	5	75	1.642	8	0.198	17	0.198		
	6	75	5.947	15	5.947				
	7	75	5.947	3	5.947				
	8	75	0.736	18	0.793				
	9	75	0.651	6	0.651				
	10	75	0.170	5	0.198				
4913A2	11	74	0.170	10	0.037				
	12	74	0.368	14	0.311				
	1	75	0.255	11	0.201				
	2	75	0.595	15	0.765				
	3	75	1.218	8	1.614				
	4	75	0.623	5	1.104				
	5	75	0.068	8	0.142	17	0.034		
	6	75	0.082	15	0.082				
	7	75	0.048	3	0.071				
	8	75	0.014	18	0.014				
	9	75	0.023	6	0.008				
	10	75	0.020	5	0.017				

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4913 OTTER CRK RES

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
491301	11	74	1.557						
	12	74	2.124						
	1	75	2.265						
	2	75	2.549						
	3	75	3.115						
	4	75	2.832						
	5	75	2.549						
	6	75	0.0						
	7	75	0.142						
	8	75	0.0						
	9	75	0.0						
	10	75	0.0						
4913ZZ	11	74	0.025						
	12	74	0.042						
	1	75	0.042						
	2	75	0.042						
	3	75	0.023						
	4	75	0.025						
	5	75	0.057						
	6	75	0.085						
	7	75	0.042						
	8	75	0.028						
	9	75	0.028						
	10	75	0.028						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/12

491301
38 10 11.0 112 01 13.0 3
UTTEH CREEK RESERVOIR
49031 UTAH

11EPALES 2111202
0031 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/09	11 45	0000	8.4	9.0	24	306	8.65	256	0.040	1.600	0.030	0.006
	11 45	0005	8.5	9.0		310	8.65	288	0.030	0.600	0.020K	0.003
	11 45	0015	7.3	8.2		303	8.65	256	0.030	0.600	0.020K	0.010
	11 45	0027	7.2	9.0		300	8.70	258	0.030	0.600	0.020K	0.005
75/08/13	15 15	0000	18.9	7.6	70	419	8.70	186	0.020K	0.400	0.020K	0.053
	15 15	0005	18.9	8.4		419	8.75	187	0.020K	0.300	0.020K	0.056
	15 15	0017	18.7	6.0		421	8.70	188	0.020K	0.300	0.020K	0.062
	15 15	0023	18.2	4.4		421	8.50	190	0.020	0.400	0.020K	0.095
75/09/25	09 15	0000	18.8	7.2	48	322	9.00	171	0.020K	0.400	0.020K	0.042
	09 15	0005	18.5	7.6		318	8.90	171	0.020K	0.400	0.020K	0.034
	09 15	0015	18.1	5.6		321	8.80	174	0.020K	0.400	0.020K	0.045
	09 15	0021	18.0	6.0		324	8.90	171	0.020K	0.400	0.020K	0.036

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/09	11 45	0000	0.057	16.1	
	11 45	0005	0.064		
	11 45	0015	0.062		
	11 45	0027	0.067		
75/08/13	15 15	0000	0.084	10.7	
	15 15	0005	0.085		
	15 15	0017	0.087		
	15 15	0023	0.124		
75/09/25	09 15	0000	0.062	8.5	
	09 15	0005	0.055		
	09 15	0015	0.078		
	09 15	0021	0.071		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

491302
38 12 08.0 111 59 16.0 3
OTTEN CREEK RESERVOIR
49031 UTAH
150891

11EPALES 2111202
0024 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/09	10 55	0000	9.6	9.2	22	455	8.60	284	0.030	0.500	0.020K	0.005
	10 55	0005	8.6	8.6		466	8.60	226	0.030	0.400	0.020K	0.013
	10 55	0015	8.4	8.8		456	8.60	242	0.020	0.400	0.020K	0.006
	10 55	0020	8.2	8.6		464	8.60	256	0.030	0.400	0.020	0.006
75/08/13	14 45	0000	20.2	8.2	54	412	8.90	179	0.020K	0.700	0.020K	0.031
	14 45	0005	20.4	8.0		415	8.90	179	0.020K	0.700	0.020K	0.032
	14 45	0015	19.7	7.6		406	8.90	181	0.020K	0.300	0.020K	0.024
75/09/25	09 00	0000	17.5	8.4	60	313	8.90	169	0.020K	0.600	0.020K	0.039
	09 00	0005	17.4	7.4		316	9.00	166	0.020K	0.600	0.020K	0.041
	09 00	0015	17.4	7.2		309	9.00	167	0.020K	0.400	0.020K	0.042

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCOT LT REMNING PERCENT
75/05/09	10 55	0000	0.053	13.0	
	10 55	0005	0.066		
	10 55	0015	0.067		
	10 55	0020	0.068		
75/08/13	14 45	0000	0.075	13.4	
	14 45	0005	0.067		
	14 45	0015	0.058		
75/09/25	09 00	0000	0.086	8.9	
	09 00	0005	0.081		
	09 00	0015	0.080		

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/12

4913A1
38 10 00.0 112 01 45.0 4
SEVIER RIVER
49 PIUTE CO MAY MAP
O/OTTER CREEK RESERVOIR
OTTER CREEK RESERVOIR DAM SPILLWAY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/10	11 30		0.104	0.500	0.040	0.060	0.080
74/12/14	11 30		0.008	1.900	0.025	0.030	0.080
75/01/11	11 20			0.500	0.045	0.065	0.100
75/02/15	10 05		0.064	0.600	0.056	0.072	0.120
75/03/08	10 10		0.733	0.350	0.016	0.112	0.140
75/04/05	10 35		0.027	0.475	0.014	0.030	0.060
75/05/08	11 30		0.005	1.350	0.130	0.025	0.040
75/05/17	12 35		1.000	2.700	0.115	0.070	0.250
75/06/15	11 00		0.005	1.100	0.035	0.020	0.050
75/07/03	11 10		0.010	0.450	0.030	0.315	0.060
75/08/18	19 10		0.005	0.750	0.015	0.045	0.090
75/09/06	11 10		0.010	2.000	0.025	0.035	0.090
75/10/05	11 55		0.005	0.400	0.005	0.035	0.070

STORET RETRIEVAL DATE 76/08/12

4913A2
38 14 59.0 112 57 55.0 4
OTTER CREEK
49 7.5 ANGLE
T/OTTER CREEK RESERVOIR 150891
BRDG ON GRVL RD .6 MI E OF ANGLE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/10	12	25	0.520	1.100	0.040	0.095	0.170
74/12/14	11	15	0.617	1.500	0.035	0.020	0.040
75/01/11	11	00	0.296	0.400	0.025	0.030	0.060
75/02/15	09	48	0.184	1.500	0.064	0.032	0.090
75/03/08	10	45	0.220	1.150	0.032	0.032	0.080
75/04/05	12	20	0.030	1.250	0.065	0.085	0.270
75/05/08	11	15	4.200	3.450	0.010	0.200K	
75/05/17	12	15	0.015	2.700	0.020	0.025	0.270
75/06/15	10	30	1.300	0.800	0.035	0.070	0.100
75/07/03	11	25	1.200	1.200	0.095		0.080
75/08/18	17	20	0.900	1.900	0.035	0.070	0.100
75/09/06	11	00	0.900	0.200	0.060	0.075	0.075
75/10/05	12	15	0.810	1.100	0.020	0.085	0.120

K VALUE KNOWN TO BE LESS THAN INDICATED

27

STORET RETRIEVAL DATE 76/08/12

491301
38 08 30.0 112 00 30.0 4
EAST FORK CANAL
49 PIUTE CO HWY MAP
T/OTTER CREEK RESERVOIR
BNK NEAR GAGE HOUSE 2.9 MI N OF ANTIMONY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/10	11	45	0.464	0.500	0.020	0.020	0.030
74/12/14	11	40	0.600	0.900	0.030	0.025	0.060
75/01/11	11	30	0.576	0.300	0.015	0.035	0.080
75/02/15	10	10	0.448	1.100	0.040	0.040	0.160
75/03/08	10	20	0.502	1.700	0.056	0.040	0.200
75/04/05	10	40	0.420	0.900	0.015	0.030	0.130
75/05/08	11	40	0.345	1.600	0.270	0.050	0.300
75/05/17	12	10	0.150	0.500	0.210	0.116	0.230
75/06/15	11	00	0.480	1.350	0.035	0.065	0.140
75/07/03	11	00	0.125	2.100	0.600	0.050	0.110
75/08/18	16	54	0.175	1.000	0.240	0.050	0.085
75/09/08	11	30	0.410	0.200	0.010	0.035	0.035
75/10/05	11	35	0.250	0.700	0.080	0.020	0.040